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Do 10 micron Interplanetary Dust Particles Sample the Bulk Composition of their Parent Bodies?

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Beamline(s): X26A

Introduction: The interplanetary dust particles (IDPs), small fragments from asteroids and comets, recovered from the Earth's stratosphere are, on average, enriched in the moderately volatile elements by ~3x over the CI meteorite composition [1]. One possibility is that the IDPs are derived from a volatile-rich parent body. Alternatively, they may sample a volatile-rich subunit of the parent body. Chondritic meteorites are dominated by two chemically distinct subunits: a volatile-rich matrix and volatile-poor chondrules and inclusions. The chondrules and inclusions are large (mm size) compared to IDPs, and may be underrepresented in the ~10 μm collision debris. A detailed understanding of the response of chondritic material to hypervelocity impact is required to infer the properties of parent bodies from the study of IDPs. To understand the disruption of chondritic meteorites, and their asteroidal parent bodies, we performed a series of impact disruption experiments.

Methods and Materials: Three ordinary chondrite meteorites, all moderately weathered finds collected in Africa, were selected as our first meteorite targets. The targets were a 235.8 gram sample of NWA791, an L6 chondrite, as well as a 248 gram sample of NWA620 and a 106.8 gram sample of MOR001, both unclassified ordinary chondrites. Each target was struck by an ~5 km/sec (comparable to the mean collision velocity in the main belt of asteroids) aluminum projectile fired from the NASA Ames Vertical Gun. The details of each shot are given in Durda et al. [2]. Some primary debris fragments were collected in aerogel blocks placed around the sample.

Results: Chemical analysis of individual particles collected in the aerogel was performed *in-situ* using the X-Ray Microprobe at beamline X26A of the National Synchrotron Light Source. We distinguish olivine chondrules from matrix by the significantly higher Ni content of the matrix. Twelve of the 19 fragments <25 μm in size in the first aerogel analyzed from the MOR001 shot had Fe/Ni count rate ratios <20 (high-Ni), while only 4 of the 29 fragments >25 μm had Fe/Ni count rate ratios <20 (see Figure 1). For the first aerogel from the NWA791 shot, 8 of 18 fragments <25 μm had Fe/Ni count rates <20, while only 1 of the 15 fragments >25 μm had Fe/Ni count rates <20. This indicates high-Ni matrix material is overrepresented in the <25 μm size fraction of the impact debris compared to the >25 μm fraction. Analysis of the NWA620 shot and other aerogel collectors from the NWA791 and MOR001 shots is in progress.

Conclusions: These results suggest that fragments <25 mm in size from hypervelocity impacts onto chondritic asteroids may significantly oversample the volatile-rich matrix material. These small particles are rapidly removed from the "debris trail" near the asteroid, spiraling towards the Sun because of Poynting-Robertson drag before most of the larger particles are broken up by collisions. Thus, IDPs <25 m m in size collected at the Earth may be biased towards the matrix composition of the asteroid, while the larger particles, collected as micrometeorites from the polar ices, may preferentially sample chondrule material. Experiments on a carbonaceous chondrite meteorite (Allende) and unweathered ordinary chondrite meteorites are in progress.

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References: [1] Flynn, G. J. et al. (1996) in Physics, Chemistry and Dynamics of Interplanetary Dust, ASP Conf Ser. **104**, 291-294. [2] Durda, D. D. et al. (2002) *Lunar & Planetary Science XXXIII,* Abs.# 1535.

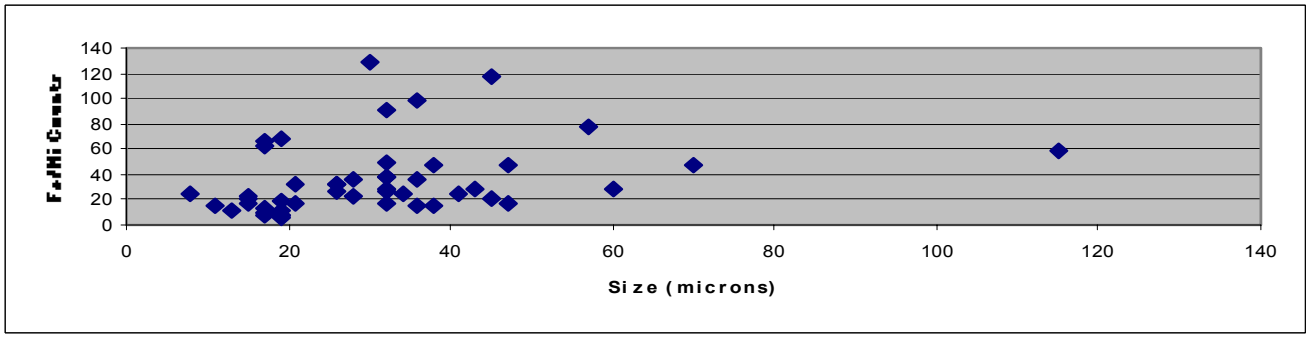

Figure 1: Fe/Ni count rates for 42 fragments of the MOR001 meteorite, showing the excess of high-Ni (Fe/Ni <20) particles among the fragments <25 m in size.